Search for the Decay $B_c \rightarrow J/\psi + e + X$

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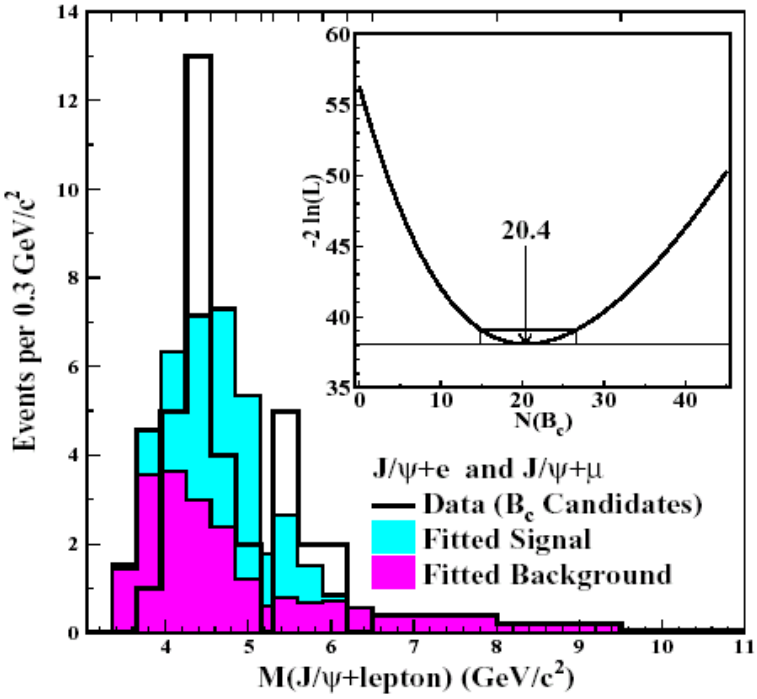
For the CDF collaboration

Introduction

- The B_c is the only meson containing two differently flavored heavy quarks (bottom and charm)
- It was first seen by the CDF collaboration in 110pb^{-1} of data collected during Run1 of the Fermilab Tevatron
  - mass ~6.4GeV (B_d~5.3GeV)
  - lifetime ~0.5ps (B_d~1.5ps)
- Today's talk is about our plan on searching for the B_c in semileptonic decay mode $B_c \rightarrow J/\psi + e + X$ using recent CDF data in Run2

CDF Run1

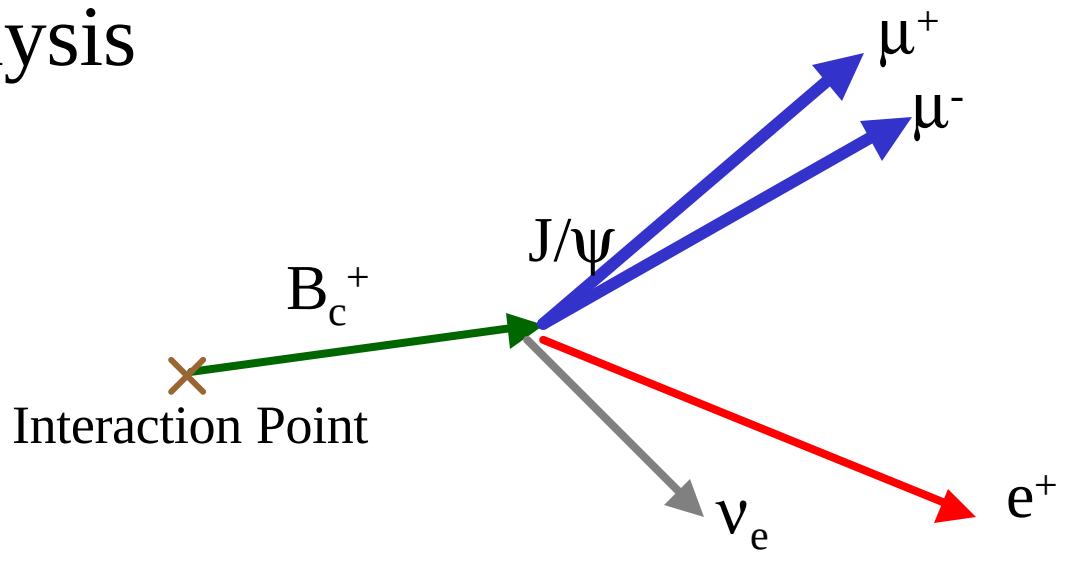


$20.4^{+6.2}_{-5.5}$ signals above background

$12.0^{+3.8}_{-3.2}$ (electron) $8.4^{+2.7}_{-2.4}$ (muon)

Reconstruction

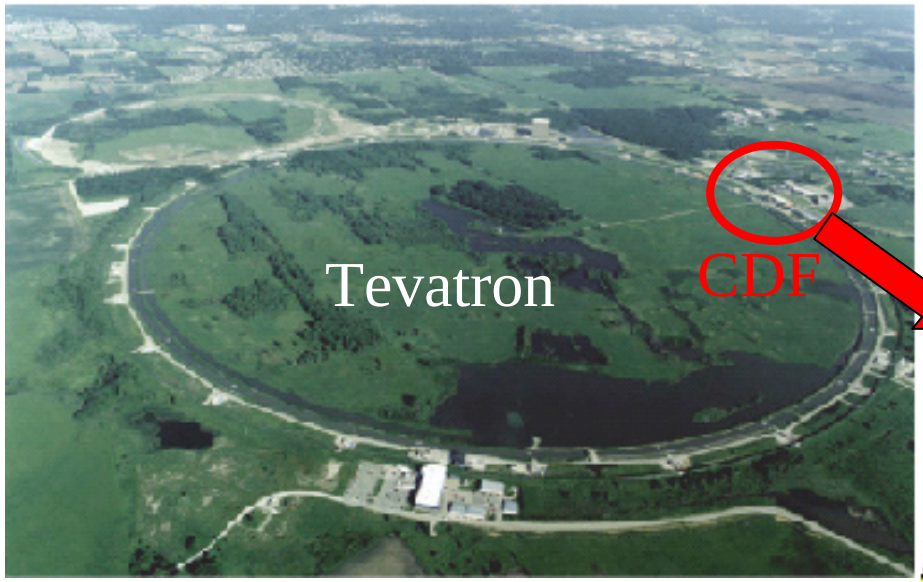
- B_c can decay to J/ψ + lepton + X(neutrino...)
- This channel has large branching fraction
  - –Theoretical prediction(hep-ph/0401237):$B_c \rightarrow J/\psi e\nu$ ~1.23%
- We use **$B_c \rightarrow J/y + e$**, followed by **J/y** $\rightarrow m^+m^-$ channel for this analysis

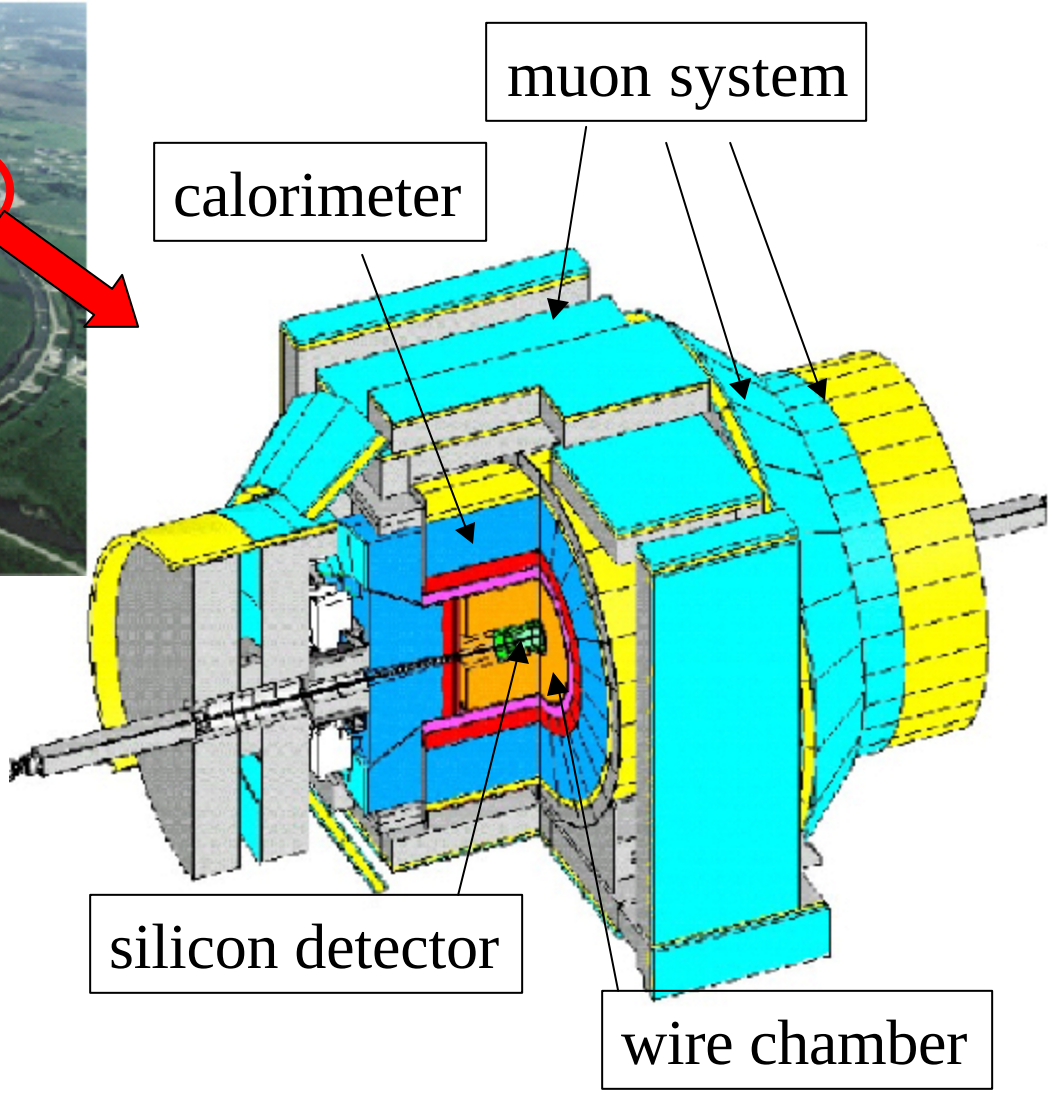


Backgrounds

- ✓ Fake electron ⇐ use data
- ✓ Real electron
  - ✓ Conversion ⇐ data and MC
  - ✓ π^0 dalitz decay ⇐ MC
  - ✓ B-Bbar background ⇐ MC
  - ✓ C-Cbar background ⇐ data and MC ?
  - ✓ (bcq) baryon background ⇐ ?
- ✓ Fake J/ψ ⇐ use J/ψ mass sideband

Tevatron and CDF detector





$\sqrt{S}$ **: 1.96 TeV**

Proton-Antiproton collider

Changes from Run1:
- Improve tracking
- Improve trigger
- Material increased
  → conversion background

J/ψ reconstruction

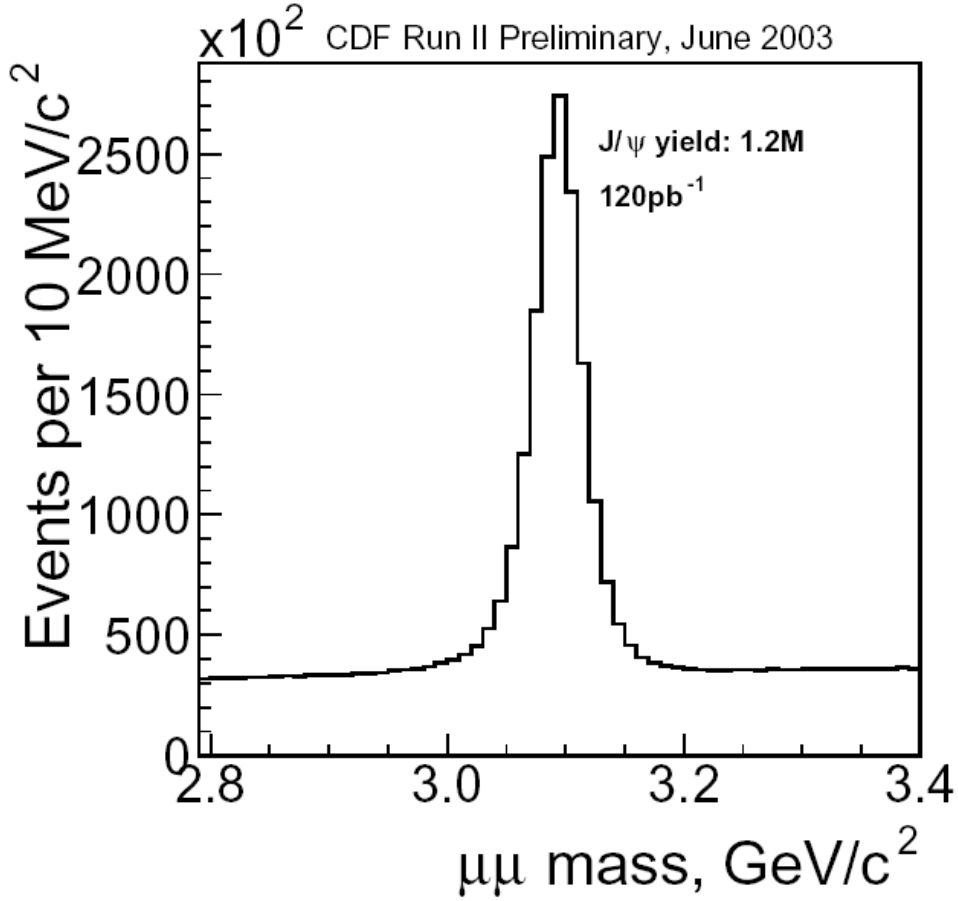
- We have

  $J/\psi \rightarrow \mu^+\mu^-$ trigger

- $p_T(\mu) \geq 1.5$GeV

  (was $\geq$ 2GeV in Run1)

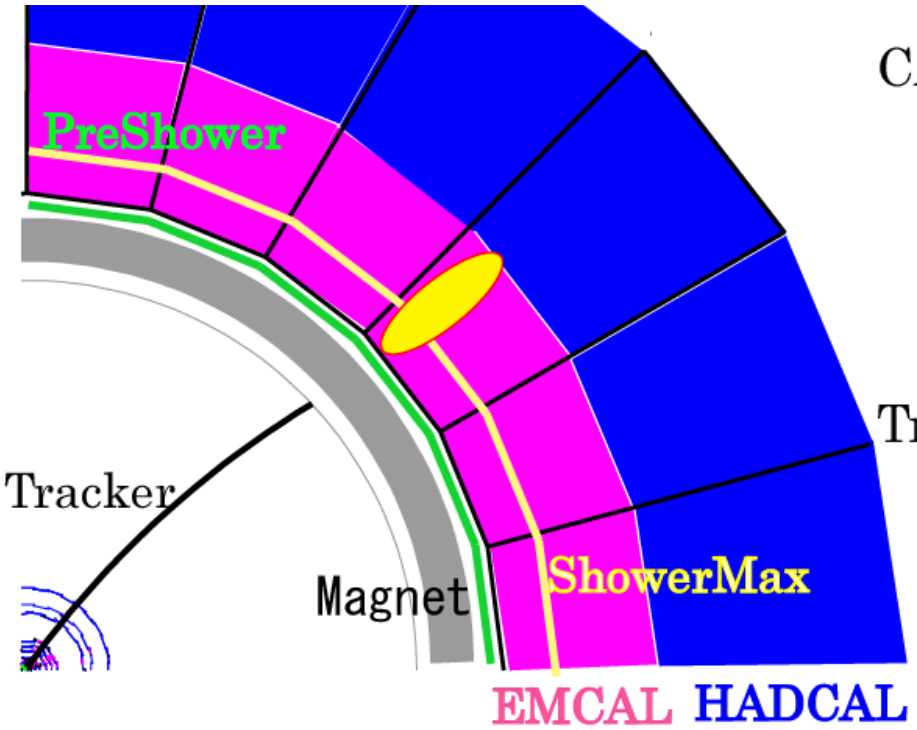
- We are collecting 5 times more yield of $J/\psi \rightarrow \mu\mu$ than Run1
  - Gain in $B \rightarrow J/\psi$ yield is ~2(b-fraction in low energy J/ψ is smaller >> see J. Krauss' talk)



Soft electron reconstruction & ID

- Track based reconstruction
- Cut based or likelihood based ID

  (Cut base was used in Run1)
- Particle ID using dE/dx



CAL based algorithm
1. Find CAL seed
2. Start CAL clustering
3. Find accosiated tracks

Track based algorithm
1. Find track
2. Extrapolate to CAL
3. Start CAL clustering

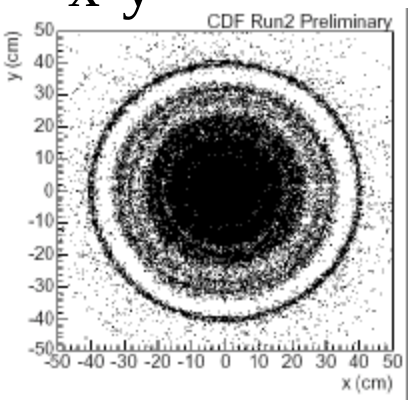
Electron and Fake sample

electron sample

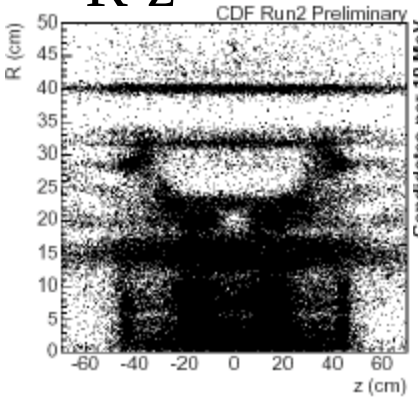
- ✓$\gamma \rightarrow ee$
- ✓$J/\psi \rightarrow ee$

Conversion points

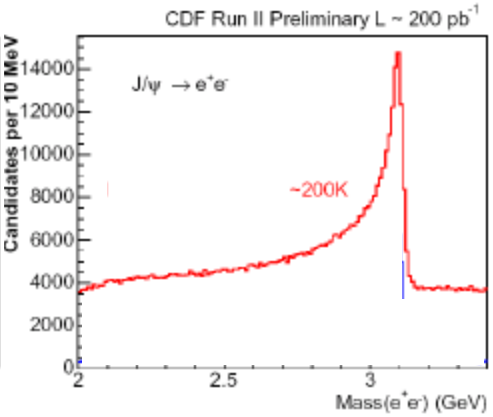
x-y



R-z



$J/\psi \rightarrow e^+e^-$

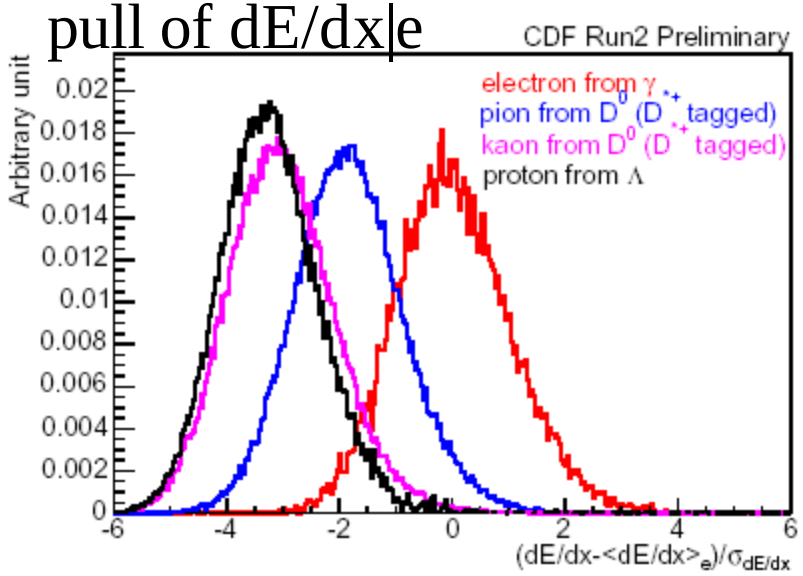


fake sample

- ✓Generic tracks
- *Leptons are removed
  - Electron : 2σ away from $<dE/dx_{(electron)}>$

  →2% electrons still remain

pull of dE/dx|e



Likelihood based electron ID

Likelihood ratio : ***L***

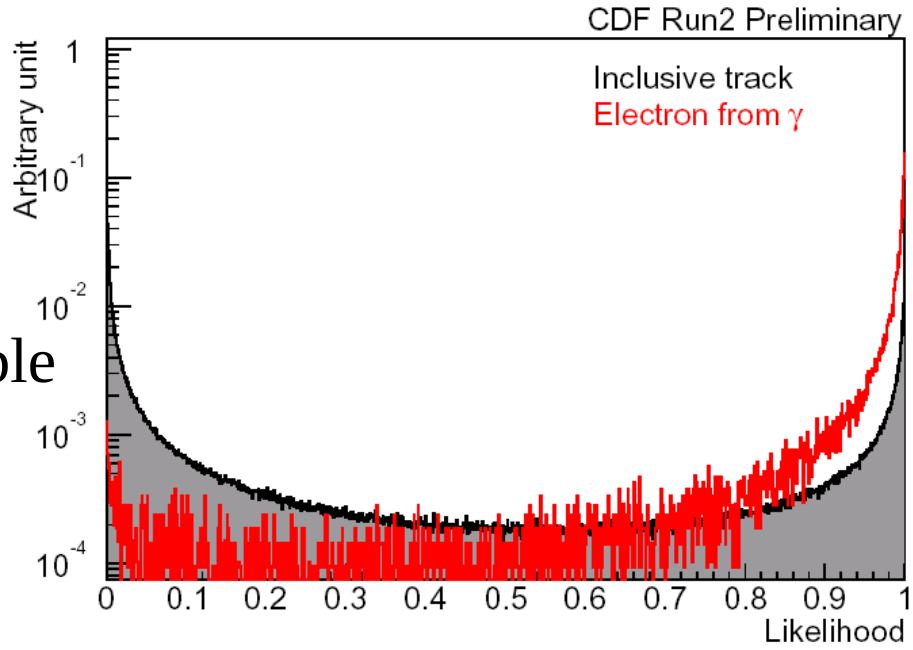
$$L = \frac{S}{S+B}$$

$$S = \prod_i P_e^i \qquad B = \prod_i P_B^i$$

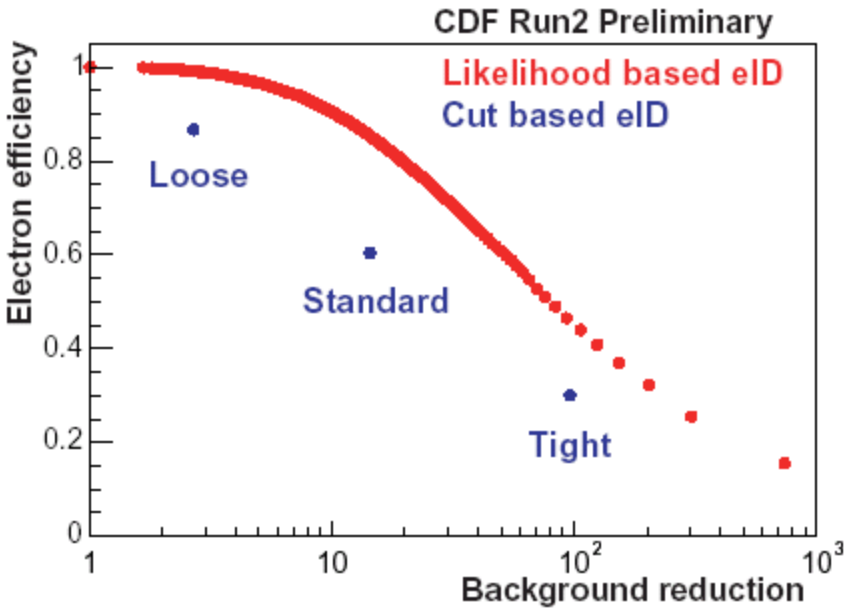
P^i : Probability Density Function

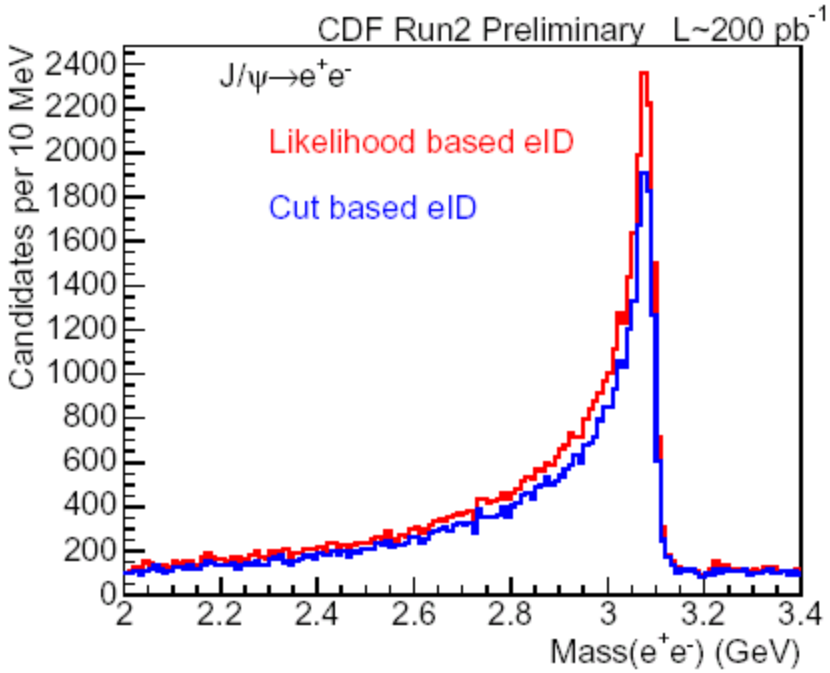
We use 9 electron quantities as PDF

- Calorimeter : 2 variables
- Shower Max : 6 variables
- Central Preshower chamber : 1 variable



Improvement by likelihood



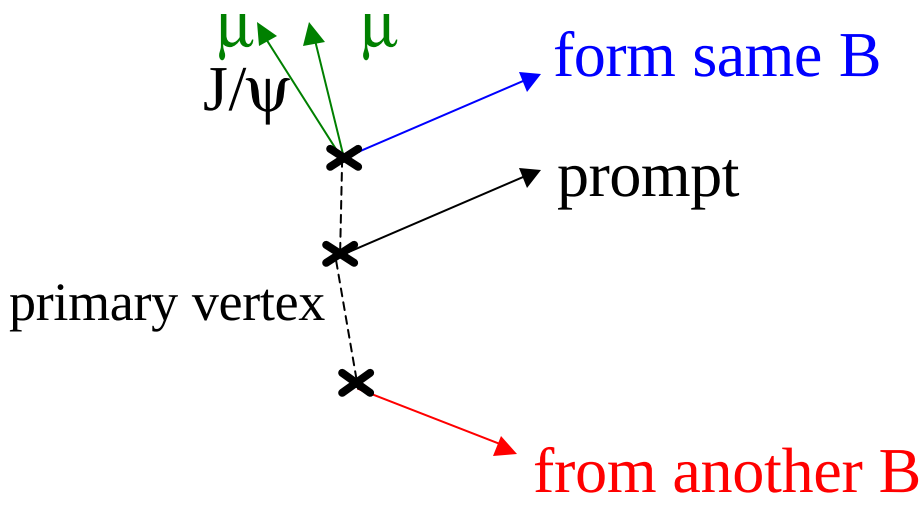


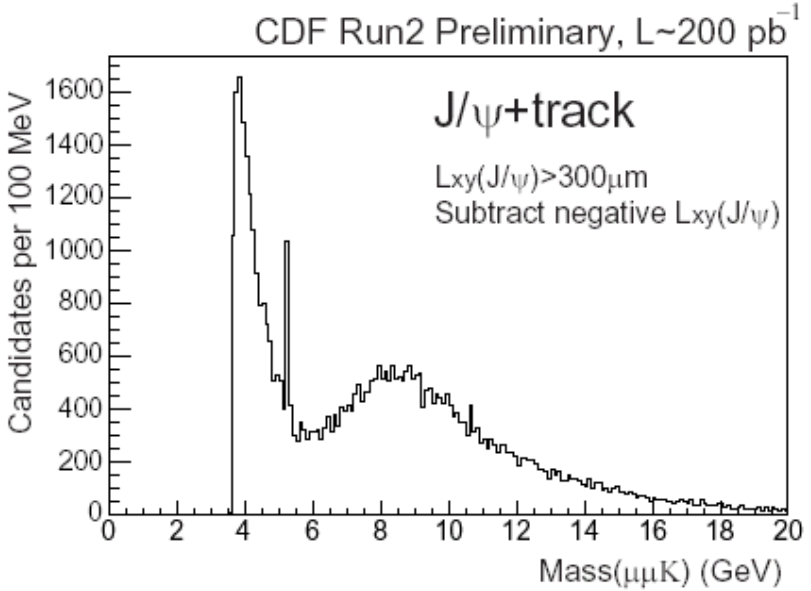
Applied cut for e^+e^-

- Cut : Standard
- Likelihood : at same reduction

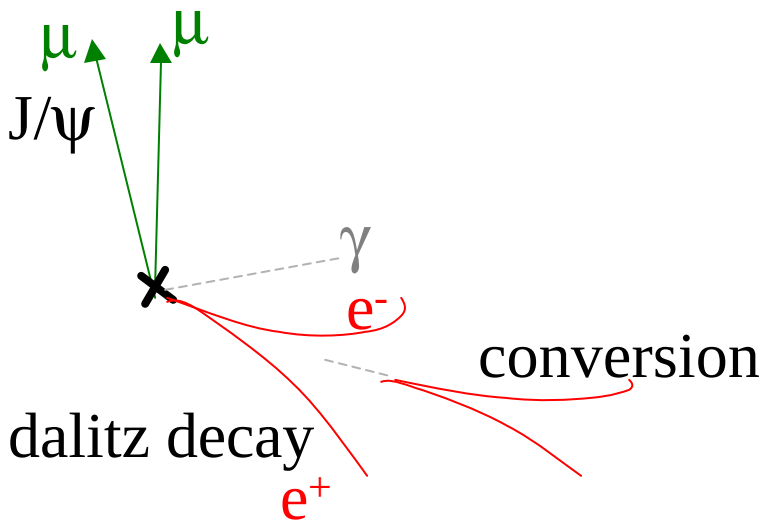
Control samples for other background estimation

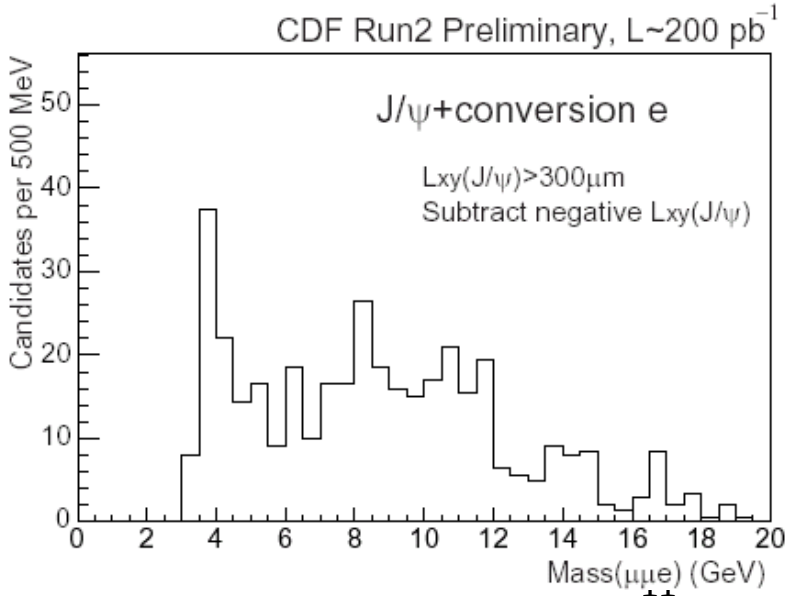
Fake electron and BBbar background





Conversion and dalitz decay background





Summary

- We are performing a search for $B_c \rightarrow J/\psi + e + X$ signal in Run2 CDF data
  - Run1 $110 pb^{-1}$ ~10 events above background (S/N~1)
- Improvements in Run2
  - More luminosities(~$250 pb^{-1}$ by FY03),
  - Tracking, electron identification, trigger...

  $\Rightarrow$ more signals
- We can precisely measure B_c signatures
  - Re-establish the signal
  - Mass, lifetime, branching fraction measurements

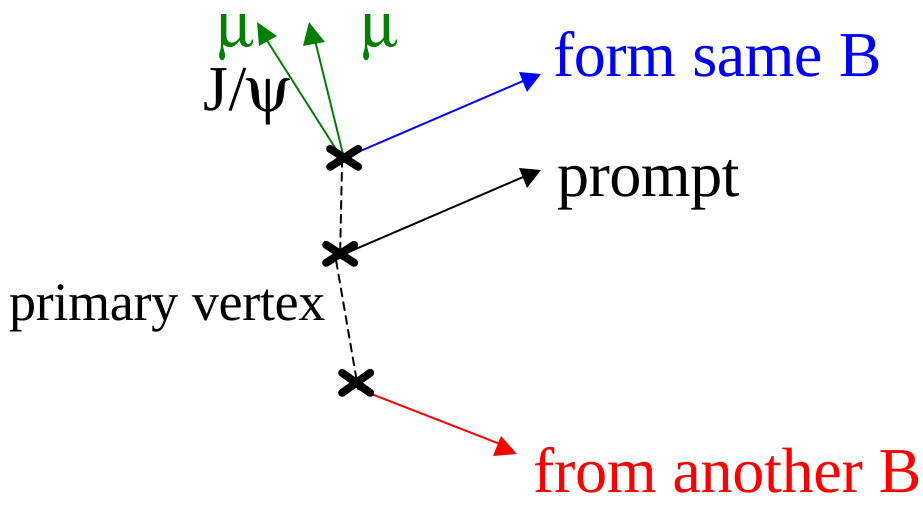
Backup Slides

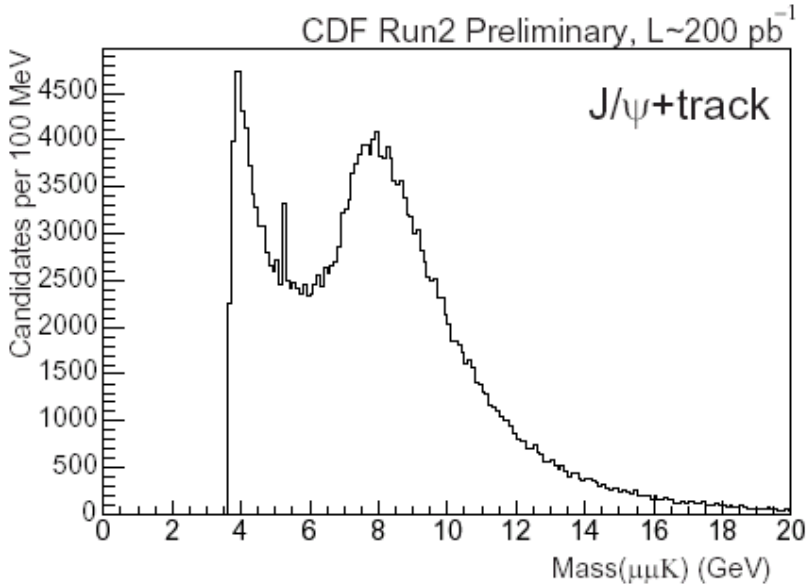
electron quantities

- Calorimeter
  - E/p
  - E_{had}/E_{em}
- Shower Max
  - E/p after correction
  - E_{strip}/E_{wire} after correction
  - $\Delta X, \Delta Z$
  - $\chi^2 x, \chi^2 z$
- Central Pre-shower chamber
  - Charge after correction

Control samples for other background estimation

Fake electron and BBbar background





Conversion and dalitz decay background